Global Coupled Atmosphere/Ocean Model for Climate and Seasonal Forecast Applications

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Coupled Atmospheric-Ocean Modeling on an Icosahedral Grid at NOAA/ESRL

Flow-following* finite volume
Icosahedral Model (FIM)

Icosahedral Ocean Model (iHYCOM)

* flow-following = vertically quasi-Lagrangian
Coupled Atmosphere/Ocean at NOAA/ESRL

**FIM atmospheric model**
- Flow-following, finite volume, quasi-Lagrangian vertical coordinate, hydrostatic dynamics
- On the icosahedral horizontal grid
- Developed at NOAA/ESRL in collaboration with NCEP: GFS column physics
- Running operationally with comparable scores to NCEP GFS (http://fim.noaa.gov)

**iHYCOM ocean model: icos HYCOM**
- HYCOM ocean model rewritten for icosahedral grid
- Sharing multiprocessor environment developed for FIM
- No need for spatial interpolation at the air-sea surface
HYCOM is short for HYBRID COORDINATE OCEAN MODEL

SSH mean: 2013.67-2013.75 91.0

Credit: NRL
Air-sea interface
HYCOM on icosahedral grid: iHYCOM

Bathymetry – 240km grid resolution (before closing Panama isthmus)
Seasonal Experiments

✧ **Uncoupled atmospheric model** FIM with observed SST, ice temperature & coverage; near zero global heat & freshwater flux at surface

✧ **Uncoupled atmospheric model 2** using the GF convection (Grell & Freitas 2013, *Atm.Chem.Phys.Disc.*);

✧ **Coupled atmospheric ocean model** FIM (based on model 2) coupled to iHYCOM

All use 60km horizontal resolution & 64 layers
Downward Surface Shortwave (W/m²)

JJA

DJF

uncoupled minus obs

uncoupled 2 minus obs

coupled minus obs
Biases in Zonal Surface Downward Shortwave Flux

- **ANN**
- **JJA**
- **DJF**

Biases in Zonal Surface Downward Shortwave Flux

**Coupled**

**Uncoupled 2**

**CFSv2**

**FIM amip**

**FIM amip+GF**

**FIM cmip+GF**

**CFSv2 amip**
Bias in Surface Downward SW

Cloud Coverage

12-mo SST drift
Ratio of Convective Precipitation to Total (%), ANN

Dai, J. Clim 2006
Summary

• Coupled FIM/iHYCOM model has the advantage of avoiding grid discontinuity at the air-sea surface, hence no need for interpolating flux coupler
• The mathematical similarity of the two models allows them to share dycore components and software engineering innovations
• FIM/iHYCOM is being developed to participate in NMME (National Multi-Model Ensemble), as well as for ESPC (Earth System Prediction Capacity) applications
• There are still large regional biases in surface shortwave flux & precipitation, most likely due to biases in cloud coverage
• Remaining climate drift in multi-year coupled runs reveals the need to further revise the column physics parameterizations in FIM/GFS/CFS via coordination between ESRL, EMC, and MAPP Process Teams